

THE WEATHER AND CIRCULATION OF DECEMBER 1961

Strong Blocking at High Latitudes

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1. INTRODUCTION

The most outstanding features of the mean circulation for December 1961 were two blocking Highs (fig. 1). A central height anomaly of +650 feet over Davis Strait, associated with the mean High over Greenland, was a December record for 700-mb. height anomaly over the Northern Hemisphere, based on 30 years of record at the Extended Forecast Branch. The departure of +570 feet attending the mean High over eastern Siberia has been only rarely exceeded in previous years.

Surface temperature anomalies in Canada and Alaska reacted sharply to blocking and related meridional flow. Over western Labrador temperatures averaged more than 16° F. above normal while at Fairbanks, Alaska, the average was 14.8° F. below normal for the month.

At temperate latitudes the circulation pattern changed considerably from November over the oceans but relatively little over the continents (fig. 2). Accordingly, month-to-month persistence of surface temperature departures over the United States (except Alaska and Hawaii) continued well above the expected level, a condition which had also prevailed the two preceding months.

2. MEAN CIRCULATION

The mean Highs over Greenland and eastern Siberia were situated near the normal positions for 700-mb. mean Lows [1], and the Lows in December were considerably displaced. One of them, which would more normally be found over Baffin Island, was located about 600 miles south of Greenland's southern tip, and the 1961 counterpart of the normal Kamchatka Low was similarly displaced southeastward. Mean heights in the troughs associated with these Lows in the western Pacific and the Atlantic were well below normal, apparently in reaction to the blocking. Heights were also below normal over most of the United States, partially in response to Canadian blocking and in resonance with a strong eastern Pacific ridge.

Zonal wind speeds for the month at temperate (35° to 55° N.) and polar (55° to 70° N.) latitudes were compatible with large-scale blocking. In the western sector of the hemisphere both temperate and polar westerlies

averaged nearly 2 m./sec. less than their respective normals. The axis of maximum west winds at the 700-mb. level (fig. 3) was, on the average, south of the usual December position from Central Asia eastward to the mid-Pacific and from the Washington coast to Spain. This displacement was most pronounced over the Atlantic, where wind speeds averaged as much as 11 m./sec. less than normal in the north and 9 m./sec. above in the south.

As a result of strong blocking in the North Atlantic numerous storms were displaced far to the south of their usual paths from Newfoundland to Iceland, into the mean sea level Low (fig. 4) some 800 miles to the south of its normal location. Large sea level anomalies appeared in association with extreme anomalies at the 700-mb. level. The strongest were as much as +21 mb. over Greenland and +18 mb. on the Siberian peninsula, -17 mb. in the Atlantic and -10 mb. in the Pacific. Over the central continental areas of North America and Eurasia these anomalies were relatively small.

Marked retrogression of a number of mean circulation features during November, including the middle-latitude waves of the western sector of the Northern Hemisphere and a deep polar Low, was described by Woffinden in a previous article [2]. In December, however, the mean features progressed except for a prominent blocking surge which retrograded from Scandinavia to Davis Strait, and the polar Low which was quasi-stationary. When the latter stalled north of Novaya Zemlya its size and strength diminished. Downstream, where mean changes from November to December (fig. 2) were as much as +700 feet over eastern Siberia, a mean ridge strengthened throughout most of December and became gradually more influential in shaping the surrounding circulation. By mid-month its 5-day height anomaly had surpassed that of the eastern Pacific ridge, and by virtue of its position provided strong northerly flow across Alaska, favoring baroclinic development in the Alaskan Gulf.

3. TRANSITION WITHIN THE MONTH

This and the subsequent evolution can be followed in half-month mean circulations and the change between them (figs. 5A, 6A, and 7). In the mean 700-mb. circula-

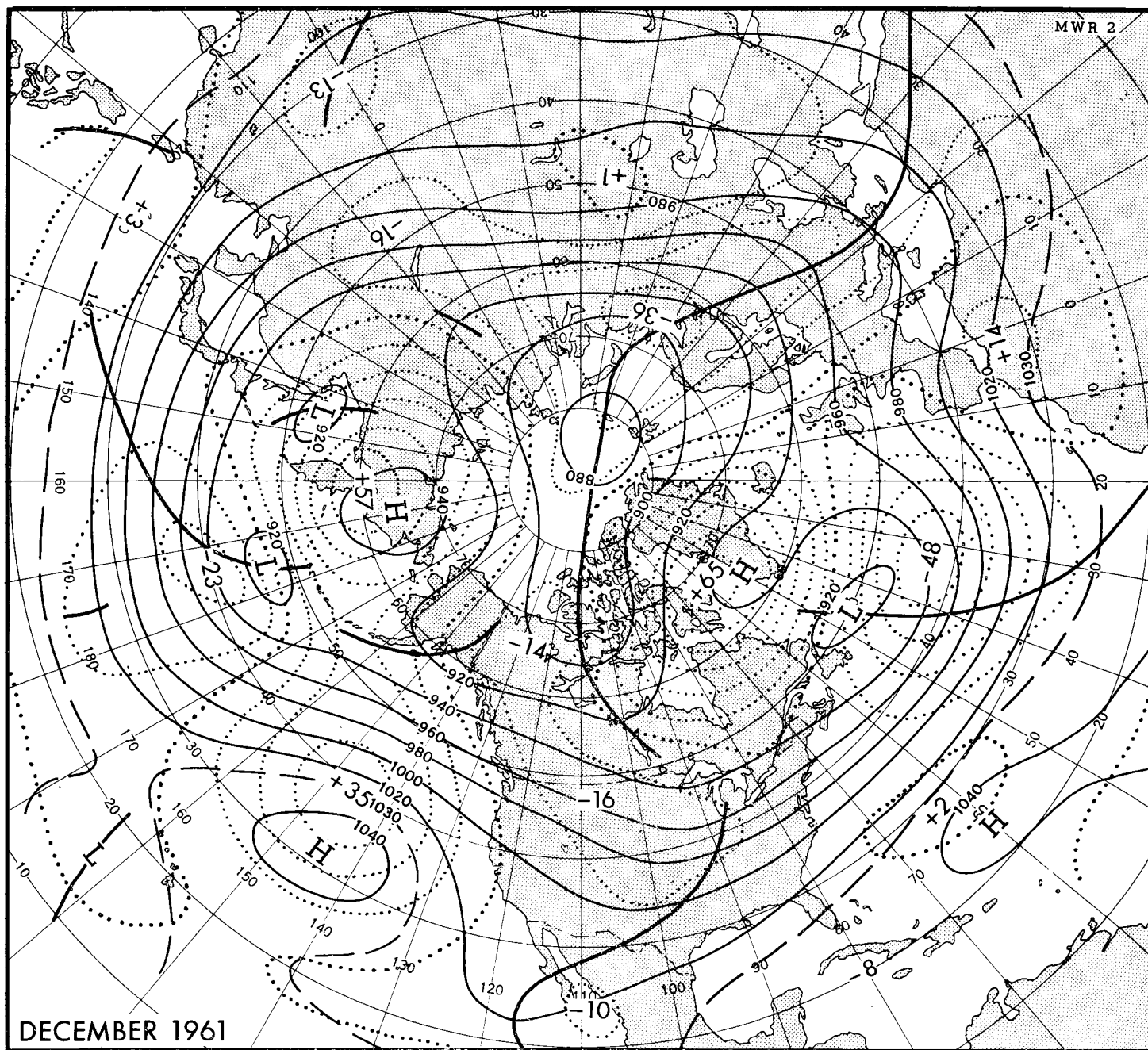


FIGURE 1.—Mean 700-mb. contours (solid) and height departures from normal (dotted), both in tens of feet, for December 1961. Positive anomaly centers over Davis Strait and near Kamchatka were extremely intense this month. Mean Lows were displaced far from normal positions.

tion for the first half of December the Kamchatka ridge was already well developed, as was the eastern Pacific ridge. The trough over North America almost coincided with the position of a similar trough in early November [2]. Another trough had advanced from western to the central Atlantic, had deepened, and (from 5-day means not shown) had become temporarily stationary by mid-month while the downstream ridge over Europe intensified. A High which became cut-off in the northern part of

the ridge, subsequently retrograded and re-intensified the blocking High over Greenland while the Icelandic Low also became cut-off and retrograded. The results of this transition are apparent in the mean circulation for the second half-month (fig. 6A) over Davis Strait where height anomalies were as much as +750 feet.

During the latter half of December the well-developed blocking High was maintained over eastern Siberia and development of the trough downstream in the Gulf of

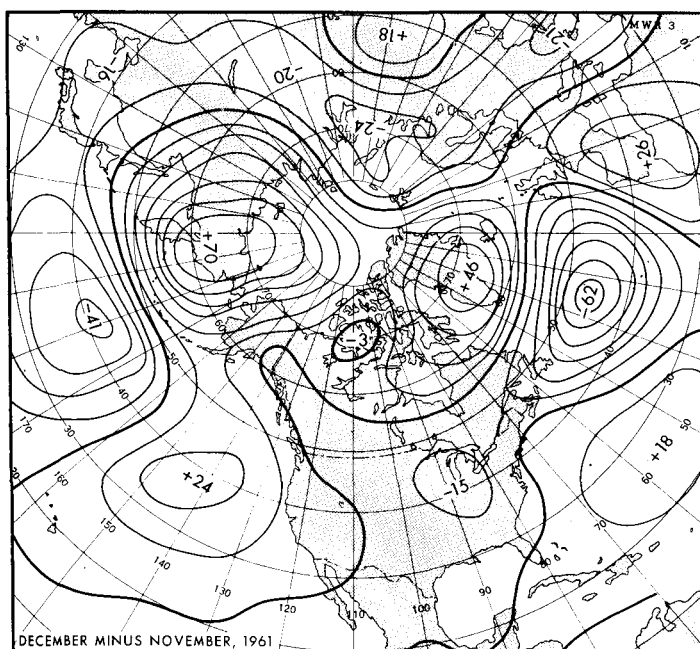


FIGURE 2.—Change in mean 700-mb. height departures from normal (tens of feet) from November to December 1961. Change patterns at middle and high latitudes of both the Pacific and the Atlantic indicate the increase of blocking.

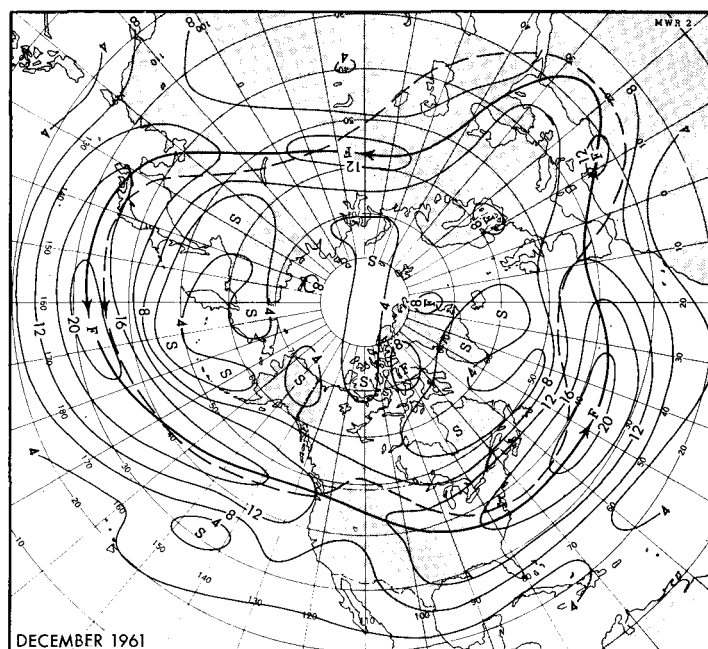


FIGURE 3.—Mean 700-mb. isotachs for December 1961. Heavy solid arrows indicate primary axes of mean maximum winds, and dashed arrows their normal December positions. Southward depression of the westerlies by blocking is apparent over eastern Asia, the western Pacific, North America, and the Atlantic.

Alaska accounted for height falls of as much as 580 feet (fig. 7) between the half-month means as a portion of the eastern Pacific ridge advanced into western North America. Further progression of the trough in the United States was accompanied by falls of several hundred feet with noticeable impact on the country's weather.

Temperatures over the western two-thirds of the United States were generally colder than normal during the first half of December (fig. 5B), in response to northerly flow between the strong mean ridge in the eastern Pacific and the trough from Lake Superior southwestward (fig. 5A). Also, most of the area was blanketed by snow from storms early in the month. During this period an unusually severe outbreak of cold air flooded parts of the West and the Central Plains from the 10th through the 13th. New December records were established at several stations, including Colorado Springs, Colo., -13° F. on the 11th and 12th; Pueblo, Colo., -28° F. on the 12th; and Topeka, Kans., -12° F. on the 12th. On the 13th Kirwin, Kans. reported -26° F., equaling the record December low for the State.

Soon afterward rapid warming occurred over the West except for the California Valleys and the Colorado Plateau, following the development of a trough in the Gulf of Alaska around mid-month accompanied by flattening of the eastern Pacific ridge, faster westerlies, and the transport of mild Pacific air into western United States. While the Canadian portion of the mean trough of early December was forced westward by the intensify-

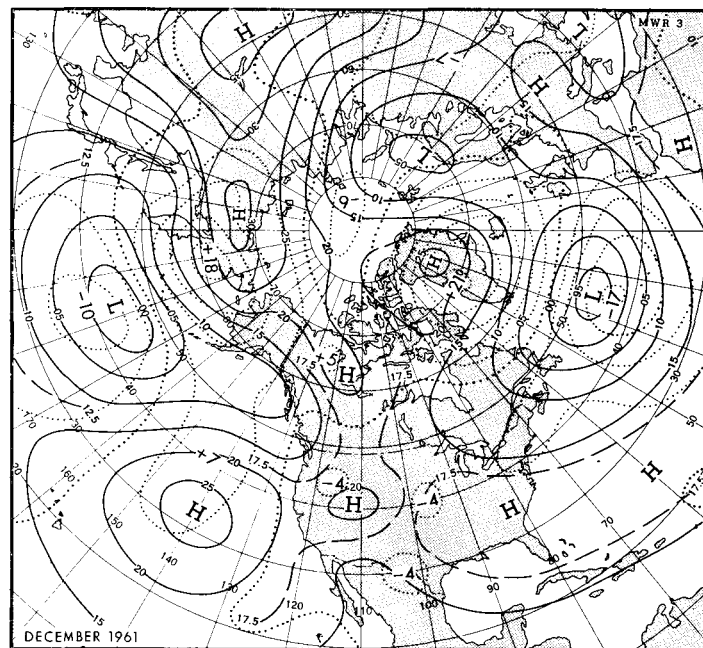


FIGURE 4.—Mean sea level pressure and departure from normal (both in millibars) for December 1961. The Icelandic and Aleutian Lows were displaced southward from normal positions by blocking Highs.

ing blocking ridge over eastern Canada, the southern part sheared and moved eastward, with a corresponding eastward shift of the cold air. Negative height anomalies for the second half of the month (fig. 6A) and half-month

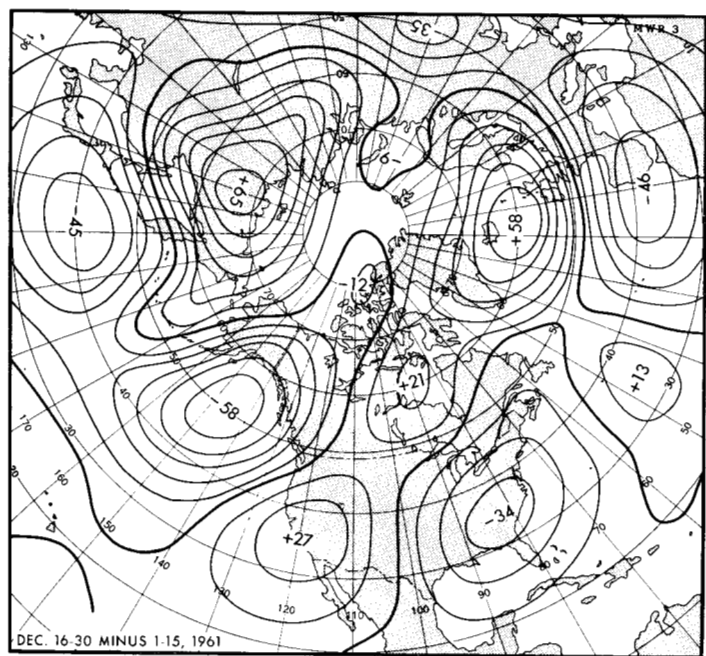


FIGURE 7.—Change in 15-day mean 700-mb. height December 1–15 to December 16–30, 1961 in tens of feet. Blocking increased over eastern Asia and the western Pacific, eastern North America, and the eastern Atlantic as the month progressed.

occurrence of snow cover at this time of year is less than 50 percent.

Over the Colorado Plateau, which remained abnormally cold long after surrounding areas had warmed (figs. 5B and 6B), another factor was present. There the cold air was trapped by surrounding mountains and protected from warming westerlies to a varying extent (depending on location) by an overlying temperature inversion. An extreme example occurred at Winslow, Ariz., where temperatures remained far below normal for weeks following a snow storm on the 10th and 11th. Thereafter fog filled the local basin and a strong inversion developed aloft that averaged 13° C. from base to top during the last 11 days of the month. The average temperature at Winslow was a record low for the month, 11.9° F. below normal.

In the coastal valleys of California there was a similarly slow response to changes of the circulation which are ordinarily conducive to warming elsewhere in the country. In this case the deterrent was valley fog, which is typically prevalent in December and was observed almost continuously after the first few days except for several days around the 20th of this month.

In California, valley fog often occurs in maritime air trapped there by an inversion which is formed and sustained by subsiding air from the Great Basin High. The earth's surface is thus shielded from insolation and advective warming, much in the way observed over the Colorado Plateau.

While sizable variations occurred during December,

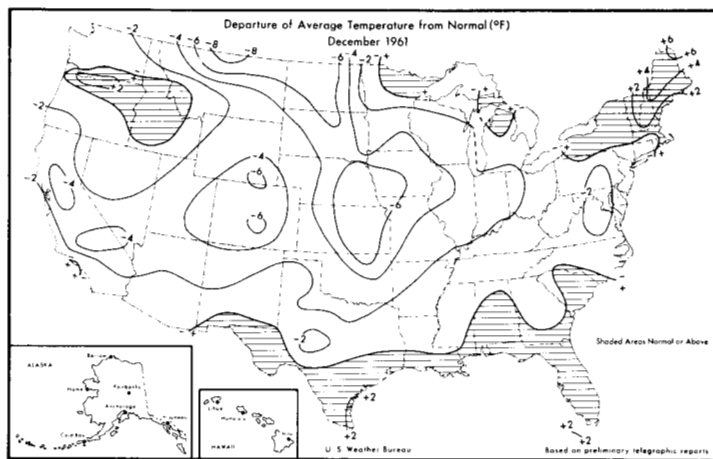


FIGURE 8.—Departure of average surface temperature from normal ($^{\circ}$ F.) for December 1961. Temperatures were predominantly colder than normal over the country. Eastern Canadian blocking accounted for the relative warmth in the Northeast (from [3]).

persistence of surface temperature anomaly over the United States from the preceding month was unusually high with 85 percent in the 0+1 class change category (5 classes at 100 representative stations). The expected change is 67 percent. The trend was toward cooling with 42 percent colder by one or more classes compared to 24 percent warmer.

Another interesting aspect of temperature was the wide range of daily readings in the interior of Alaska. At Fairbanks the monthly extremes were $+25^{\circ}$ F. and -62° F., and at McGrath the high was $+41^{\circ}$ F., the low -67° F. The warm extremes came early and the cold late in the month. Intensification of the northerly component of mean flow (see the change field of fig. 7) as the month progressed contributed to the cooling trend over Alaska.

5. PRECIPITATION

Very heavy precipitation, some of record-breaking proportions (see table 1 and fig. 9), occurred in the central Gulf States and the Tennessee Valley in December. The heaviest rain fell between the 4th and the 18th during the approach of the mean trough and was largely produced by over-running of a warm southwesterly current from the Gulf of Mexico above cool air near the surface. Weekly totals in this period ranged locally to 15 inches and caused flooding in Mississippi and Alabama. Record flood stages were reported at Bovina and Jackson, Miss. on the 21st. River stages were 28 feet over flood level and still rising on the 26th at Jackson, Ala. By the 29th however, cool dry air had swept into the flood area and temperatures thereafter remained mostly below normal with light precipitation. Flood waters were receding by the end of the month.

At Yuma, Ariz., more rain fell in 24 hours around mid-month than had accumulated during the rest of 1961.

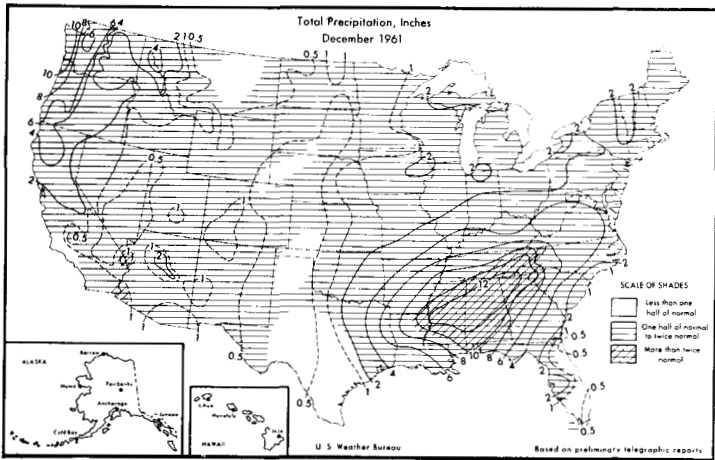


FIGURE 9.—Total precipitation in inches for December 1961. Heavy rains caused locally severe flooding in the Southeast (from [3]).

This was the first month with above normal precipitation at that station since June 1960. A Kona-type storm at Kauai, Hawaii, brought heavy rainfall from the 4th to the 6th. Lihue, Kauai reported 4.20 inches during the storm, over two-thirds the total for the month.

Heavy snowfall over the Central Plains was more extensive than usual. Omaha, Nebr., Kansas City and St. Joseph, Mo., and Des Moines, Iowa, all with long periods of record, reported their largest totals of December snowfall. Snow remained continuously on the ground at these and many surrounding stations after the 8th. In northwestern New York snow accumulations were unusually

TABLE 1.—Amounts of heavy precipitation at selected stations in December 1961

Station	Amount	Remarks
Birmingham, Ala.	13.98	Dec. record (since 1895).
Vicksburg, Miss.	13.91	Dec. record.
Chattanooga, Tenn.	13.68	Dec. record (since 1879).
Rome, Ga.	13.46	Dec. record.
Meridian, Miss.	12.28	Dec. record.
Huntsville, Ala.	12.17	
Knoxville, Tenn.	11.63	
Montgomery, Ala.	11.35	Dec. record (since 1873).
Jackson, Miss.	11.16	
Mobile, Ala.	10.92	

light until the end of the month when Buffalo reported more than 2 feet on the 29th and 30th. This snow did not extend to the traditional snow belt of that region however.

Deficient monthly amounts of precipitation (fig. 9) were reported just east of the Continental Divide from Montana to Texas, where mean west-northwesterly flow is usually dry because of the loss of moisture in crossing the Rockies. Other dry areas were the Los Angeles Basin of California and parts of Florida, where Miami reported its driest December since records began in 1911.

REFERENCES

1. U.S. Weather Bureau, "Normal Weather Charts for the Northern Hemisphere", *Technical Paper* No. 21, Washington, D.C. 1952.
2. C. M. Woffinden, "The Weather and Circulation of November 1961," *Monthly Weather Review*, vol. 90, No. 2, Feb. 1962, pp. 71-78.
3. U.S. Weather Bureau, *Weekly Weather and Crop Bulletin*, *National Summary*, vol. XLIX, No. 2, Jan. 8, 1962.